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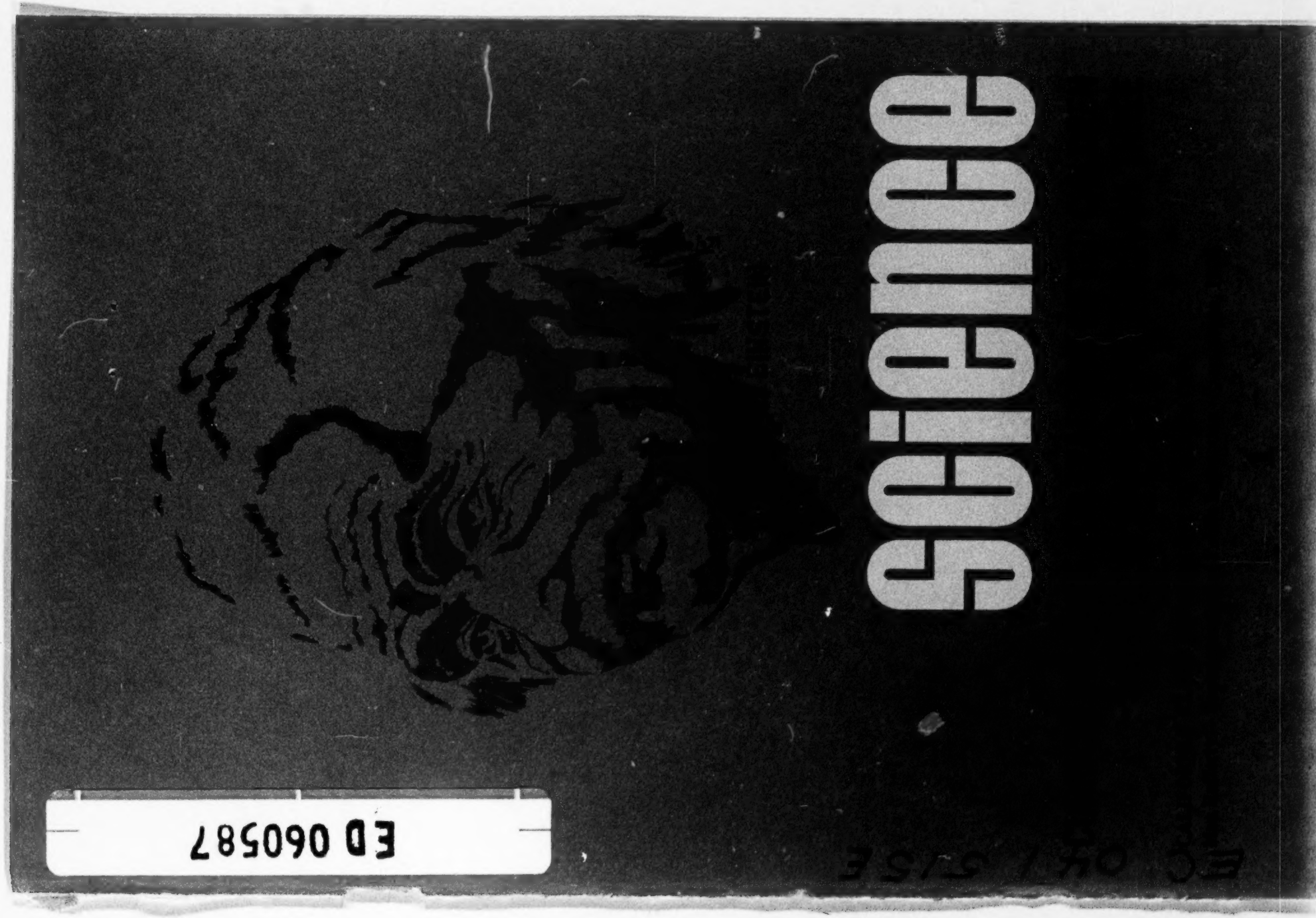
ABSTRACT

The curriculum guide for teaching science to gifted primary grade children in California focuses on natural science, with an emphasis on ecology. Provided are a general overview of the unit, a set of behavioral objectives, a list of generalizations and concepts, a sample teaching-learning plan for the complete unit, and eight sample lesson plans. Each lesson takes up a different ecological topic: substratum, animal movement, seed dispersal, temperature's influence on environment, light, food, water, and erosion. Each lesson plan includes behavioral objectives, teaching strategies, suggested questions and activities, and suggested resource materials. (KW)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CURRICULUM GUIDE FOR TEACHING GIFTED CHILDREN
SCIENCE IN GRADES ONE THROUGH THREE

Prepared for the
DIVISION OF SPECIAL EDUCATION
California State Department of Education

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FOREWORD

California public schools should provide equal opportunity for every girl and boy of school age to become knowledgeable in the basic subjects and proficient in using the basic skills of learning. And the educational programs offered by the schools should be of sufficient scope and depth to permit each child to learn at the rate and to the full level that his ability permits.

In conducting their educational programs, the schools must employ practices that are sufficiently flexible to permit the adjustments required to meet each pupil's need of special education. The talented are among those for whom such adjustments are necessary. Recently the State Department of Education directed and coordinated a federally funded project for the development of curriculum materials of the type needed for this program. The materials, which reflect the best thinking of people who are well qualified both by education and by experience, are innovative and professional.

This curriculum guide, one of a series, is concerned with the teaching of science to mentally gifted pupils in grades one through three. The concepts and suggestions contained in it merit thoughtful attention, appropriate interpretation, and wise application.

Max Rafferty

Superintendent of Public Instruction

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PREFACE

This curriculum guide, which was planned and completed as part of a project under provisions of the Elementary and Secondary Education Act, Title V, is designed to be used by teachers of mentally gifted children whose general mental ability is in the top 2 percent of all girls and boys.

Curriculum Guide for Teaching Gifted Children Science in Grades One Through Three is one of a series of curriculum guides that are designed for the following educational levels: grades one through three, four through six, seven and eight, and nine through twelve. The guides were prepared under the direction of John C. Gowan, Professor of Education, and his assistant, Joyce Sonntag, Assistant Professor of Education, both of San Fernando Valley State College.

A curriculum framework that is designed for use in planning and implementing programs for mentally gifted minors was also developed in the project. This framework was prepared under the direction of Mary N. Meeker, Associate Professor of Education, University of Southern California, and James Magary, Associate Professor of Educational Psychology, University of Southern California.

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CHAPTER 1

Purposes and Approaches

It is the intent of this guide to help gifted pupils in grades one, two, and three to take active part in meaningful learning activities that concern the world of natural science. The emphasis of the unit is on ecology and on various aspects of that branch of science, such as the biological, the environmental, and the geological.

Overview

Chapter 1 includes a general view of the unit, a set of behavioral objectives, and a list of generalizations and concepts. Chapter 2 offers a sample teaching-learning plan for the complete unit. Chapter 3, dealing with the subject matter of the unit, contains eight sample lesson plans; each lesson takes up a different ecological topic.

Each of the eight lessons in this unit typically begins with an appraisal of the knowledge the pupil may already possess. The children are then asked to organize their knowledge into useful patterns so that they may be able to apply it to gain new insights. Experiments and investigations are done individually or in small groups and are followed by sharing observations with the larger class group.

Much of the work is carried on through group discussion, for it is during the use of this technique that the pupil puts his ideas into words. The willingness of the teacher to accept unusual ideas while requiring some justification for the ideas is the key to setting the classroom climate and is a highly effective means of motivating the pupils to commit themselves with enthusiasm to this work.

Creative writing activities may have a very personal meaning for some of the pupils; their efforts should be kept private if they do not wish to share them. Grade marks in achievement should not be given for these activities, and the children should be aware that no marks will be recorded. The purpose of the creative writing activities is to give pupils an opportunity to express their feelings about nature.

Behavioral Objectives

In the preparation of this guide, ample attention has been given to the research of Jerome S. Bruner, of J. P. Guilford and P. R. Merrifield (University of Southern California), and of Benjamin S. Bloom and his associates. Special attention has been directed to the cognitive and affective domains of learning, as explored in *Taxonomy of Educational Objectives.*[1] Certain functions in those domains are designated in the list of objectives that follows:

- The pupils will express a desire to know why organisms behave as they do in the organisms' environments. (Knowledge, response)
- The pupils will identify specific information needed to answer their questions. (Comprehension, response)
- The pupils will seek means to answer their questions through experiments, resource materials, and resource personnel. (Comprehension, analysis; receiving, responding)
- The pupils will share information, as well as identify needs when information is lacking, by means of class discussions. (Analyzing, responding, valuing)
- The pupils will classify information according to appropriate categories. (Comprehension, response)
- The pupils will find relationships between environmental conditions and the ways in which organisms respond. (Synthesis, organization)
- The pupils will express feelings of responsibility for man's role in ecological balance. (Evaluation, characterization)
- The pupils will recognize and express an appreciation for the aesthetic qualities of nature through interpretive behavior. (Application, synthesis; responding, valuing)

Generalizations and Concepts

After the children have completed the unit, it is expected that they will have come to understand and appreciate the following generalizations and concepts:

- The substratum is the base on which an organism lives.

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[1] *Taxonomy of Educational Objectives: The Classification of Educational Goals.* In two volumes. *Handbook I: Cognitive Domain;* edited by Benjamin S. Bloom and Others, 1956. *Handbook II: Affective Domain;* edited by D. R. Krathwohl and Others, 1964. New York: David McKay Co., Inc.

- Organisms have certain physical characteristics that enable them to live on or in their substrata.
- Animal movement falls into types of movement that are made possible by certain physical characteristics which the animals possess.
- Survival of the species is related to animal movement, as in the instances of migration, self-protection, and the seeking of food.
- There is beauty in the movement of animals.
- Seed dispersal is identified according to types of dispersal that are made possible by certain characteristics of the seeds.
- Improved chances of germination are related to the type of seed dispersal within a given environment.
- Scientists of the past have used techniques which can be duplicated by elementary students.
- There is a large number of dormant seeds in the soil.
- Life would not exist in the way that we know it if the heat from the sun were lost.
- Man adjusts temperature extremes to suit himself through artificial temperature-control devices.

CHAPTER 2

Sample Teaching-Learning Plan

The following sample shows the type of teaching-learning plan that can be drawn up for a science unit for gifted pupils in grades one through three.

A Unit on Ecology

Ecology is the study of the relationships between organisms and their environments. This unit consists of eight lessons, each of which pertains to an important aspect of ecological science: Substratum, Animal Movement, Seed Dispersal, Temperature, Light, Food, Water, and Erosion. Suggested activities and assignments for the pupils are listed under each topical side head.

Substratum

1. Identify various substrata.
2. Recognize characteristics of substrata.
3. Observe organisms' physical adaptations to substrata.

Animal Movement

1. Identify and classify types of movement.
2. Determine the relationship between the movement and the substratum.
3. Relate the movement to the survival of the species.
4. Appreciate the aesthetic qualities of movement.

Seed Dispersal

1. Identify and classify categories of seed dispersal.
2. Relate dispersal to the survival of the species.
3. Learn of earlier research techniques.

Temperature

1. Recognize the necessity of receiving heat from the sun to life on earth.
2. Identify ways in which organisms adapt to temperature changes.

Light

1. Investigate responses of organisms to light.
2. Experience human adaptive powers in response to lack of light.

Food

1. Establish a relationship between organisms and their sources of food.
2. Observe physical characteristics of organisms that enable them to obtain food.
3. Become aware of some causes of famine and ways in which food supplies can be restored.

Water

1. Experiment to understand (a) movement of water through a growing plant; (b) transpiration; and (c) water-seeking roots.
2. Learn of physical adaptations – on the part of some animals – that compensate for a lack of water in their environment.
3. Become aware of man's efforts to provide himself with an adequate water supply.

Erosion

1. Experiment to observe causes of erosion.
2. Relate erosion to ecological balance.
3. Consider man's role in erosion control.

Evaluation

As the children proceed through the unit, it would be well, of course, for the teacher to evaluate as often as possible the progress they are making. Techniques employed, materials used, degree of enthusiasm shown, and any problems that might be manifested should be appraised.

Moreover, the pupils should be encouraged to make their own evaluations and be given whatever guidance they need in this effort. The pupils need (1) to understand why self-evaluation is important to learning; and (2) to develop gradually and securely the habit of making meaningful evaluations by themselves.

CHAPTER 3

Sample Lesson Plans

The eight proposed lesson plans on the study of ecology are presented in this chapter. Each lesson identifies behavioral objectives, recommends teaching strategies, suggests pupil activities and experiences, and includes lists of resource materials.

Lesson One: Substratum

This initial unit is intended to be used with a cluster group or with an entire class. Much of the work is based on verbalization of ideas. The teacher should recognize that verbalization of self-generated ideas may take a great deal of courage on the part of some of the children. Willingness of the pupils to share knowledge and to admit lack of knowledge can be nurtured through a respectful attitude on the part of the teacher. In this way the teacher will be acting as a model upon which the children can base their own behavior.

Behavioral Objectives

The pupils will frame questions with the clarity and the specificity necessary to get information. (Analysis, response)

The pupils will formulate a definition of *substratum.* (Synthesis)

The pupils will be able to identify numerous examples of substrata and some organisms that live on them. (Knowledge)

The pupils will receive and respond to the ideas of other members of the group or class. (Receiving, responding)

The pupils will use resource materials to find answers to questions left unanswered by their observations. (Response, analysis, application)

The pupils will share new knowledge with the rest of the group or class. (Responding, valuing)

The pupils will communicate to the group or class their understanding of the relationship between substratum and the physical

characteristics of the organisms living on the substratum. (Comprehension, application, response)

Teaching Strategies

The teacher provides a challenging way of arriving at the meaning of substratum by showing a film, identifying the substratum, and then having the children define the term.

The teacher illustrates the interrelationships among concepts and asks the pupils to generate additional illustrations.

The teacher allows time for the boys and girls to receive and respond to ideas of individual learners.

The teacher encourages pupil-directed learning by providing an opportunity for observation and investigation of the physical characteristics of earthworms.

The teacher stimulates further reading by anticipating needs and making suitable references easily accessible.

Suggested Activities

Show the film, *Life on a Dead Tree.*

Identify the dead tree as the substratum for ants, lizards, beetles, and the like.

Ask the pupils to try to define substratum on the basis of this information only. Substratum can be defined as the base on which an organism lives.

Show two films, *Life in a Vacant Lot* and *The Freshwater Pond.* Show the first one with the sound turned off. Ask the children to speak up, while the film is being shown, to identify the substrata and the organisms living on them. Show the second film in the usual manner.

Ask the pupils to pool their knowledge and identify other kinds of substrata that are already familiar to them; for example, dry sand, freshwater streams, rotting leaves, and a stagnant pool.

Have the boys and girls make a bingo-like game by writing the names of nine different substrata in nine squares on 9″ x 9″ cards. Each card should have the names of the substrata arranged in a different order. From small cards with organisms' names written on the front and the matching substratum written on the back, read to the pupils the names of the organisms that live in the various substrata. The children should cover the appropriate substratum squares on their cards with markers when they hear matching organisms named. Three substrata covered in a straight line make a bingo. A check for correctness of answers can be made by referring to the back sides of the teacher's cards.

Provide a live earthworm and a magnifying glass for each pupil.

Allow time for the children to become familiar with the worms' characteristics.

Ask the pupils to find out how the worm moves. (They should be able to see with the magnifying glasses, and feel with their fingertips, small bristly appendages known as setae.)

Ask the children whether the presence of setae completely explains how earthworms move within the soil. (It is expected that the pupils will recognize that a way to dig is also necessary. They may even be able to observe their earthworms eating their way through the soil.) Give the children sufficient time to try to find an answer to this question.

As a group, the learners should consider how other needs of earthworms are met. They might discuss such needs as food supply, knowing where to go, breathing, and so forth.

Pupils finding answers to these questions through observation of their worms should share their findings with the group or class as soon as they become aware of their new knowledge.

Answers to questions still unanswered should be sought by the learners in reference materials made available by the teacher.

Save the earthworms in a jar of damp earth.

Show the film, *Life in the Ocean.*

The pupils should be instructed to watch for examples of organisms that have different physical characteristics and use different ways to achieve similar results within the same substratum. An example would be the ways in which an octopus, a fish, and a starfish move about. These three creatures have different physical structures and move in different ways; and yet they all exist within the same substratum.

Instruct the children to look through resource materials and try to find an interesting example of a physical characteristic that permits an organism to survive in its particular substratum.

Then let each pupil present his example to the group or class. Encourage a variety of kinds of presentation, such as the use of large illustrations or models, chalk talks, live demonstrations, or oral reports. The following exemplify the kinds of things that can be reported on: birds' feet, which are adapted to holding on to branches; frogs' eyes, which have transparent lids that close under water; and lizards' skins, which preserve the body moisture of lizards.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Magnifying glasses – one per pupil
Movie projector (16mm)

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MATERIALS FOR ACTIVITIES

Cards scored like bingo cards (large size, 9″ x 9″)

Cards with names of organisms written on the fronts and kinds of substrata designated on the backs (small cards)

Earthworms – one per child (available at fishing supply outlets)

Large jar containing damp earth

Markers for a bingo-like game

SELECTED REFERENCES

Books and Articles:

Anderson, Margaret J. "The Underwater World of the Caddisfly," *Nature and Science,* V (July 8, 1968), 14-15.

Hogner, Dorothy Childs. *Earthworms.* New York: Thomas Y. Crowell Company, 1953.

Ripper, Charles L. *Moles and Shrews.* New York: William Morrow and Co., 1957.

Selsam, Millicent, and Betty Morrow. *See Through the Sea.* New York: Harper & Row Pubs., 1955.

Films:

The Freshwater Pond. Encyclopaedia Britannica Films, Inc., 1962.

Life in a Vacant Lot. Encyclopaedia Britannica Films, Inc., 1966.

Life in the Ocean. Film Associates of California, 1955.

Life on a Dead Tree. Film Associates of California, 1957.

Lesson Two: Animal Movement

The characteristic movements of plants and animals are basic to a study of ecology. This lesson concentrates on the movements of various kinds of animal life. Young children are naturally curious about animals, large and small, and can, under appropriate instruction and guidance, learn a great deal about animal movement and related behavior. The content suggested here is suitable for use by an entire class.

Behavioral Objectives

The pupils will be able to identify some basic types of insect movement and to classify insects within these categories. (Comprehension, knowledge)

The pupils will be able to recognize some physical characteristics that enable insects to move in the ways they do. (Extrapolation)

The pupils will want to investigate physical characteristics of insects to determine how they are able to move. (Response)

The pupils will explain the relationship between animal movement and the substratum. (Comprehension, response)

The pupils will describe the relationship between migration and survival of the species. (Application)

The pupils will contribute ideas while considering questions about migration. (Response)

The pupils will express appreciation for the aesthetic qualities of animal movement through the use of various art forms. (Valuation)

Teaching Strategies

The teacher will provide opportunities for observation of physical characteristics of insects and animals with which the children are familiar.

The teacher will encourage the pupils to form hypotheses and to become aware of missing links in their information by means of group discussions.

The teacher will incite knowledge exploration by asking provocative questions.

The teacher will provide resource materials.

The teacher will give the children opportunities to express some of their ideas in three-dimensional art forms.

The teacher will help the pupils to develop visualization skills and awareness by showing them a way to describe views from an unaccustomed vantage point.

The teacher will reinforce originality by providing a receptive atmosphere.

Suggested Activities

Arrange a study trip to a vacant lot, a stream, a pond, or a backyard. (Parks and public areas are often sprayed for the elimination of insects and would have very little to offer.) Ask the pupils to observe the way insects move and where they go. The observations should be recorded and tabulated during the trip to identify the most frequently used mode of movement and its purpose. Encourage the children to catch samples of the kinds of insects they discover along the way or at the site chosen. Feet, wings, and other distinguishing appendages or parts should be examined with magnifying glasses. Sketches can be made during the trip or later at school if the pupils desire to do so.

Supervise an insect race. Provide a sheet of paper with a large circle drawn on it. Mark the center of the circle. Have each pupil place an insect of his choice (no flying insects) at the center and watch closely to see which insect gets to the outside of the circle first. About five insects may race at a time.

Show the film, *Wonder of Grasshoppers.* Then conduct a class discussion to compare characteristic parts of the grasshopper, such as

the mouth, the legs, and the feet, with those of other insects seen on the study trip.

Show the film, *Animals – Ways They Move.*

Arrange a library period during which the learners can examine books and articles having to do with animal movement.

Ask each pupil to think of an animal he especially likes and to make a model of it out of clay.

Have each child arrange or construct a simple background to illustrate the substratum on which the animal of his choice lives. Encourage him to point out the physical characteristics that permit his animal to be mobile on or in its particular substratum.

Ask what changes of environment take place in Canada and in our northern states in the late fall and early winter. (Temperature and availability of food are the factors to be emphasized.)

Continue questioning in the following manner:

- "How do birds survive with no fruits, seeds, or insects available in the winter?"
- "Why don't all birds just stay in the warmer areas of the country all of the time?"
- "Do salmon and ducks have the same reason for migrating?"
- "What would happen to the salmon if they stopped migrating?"
- "Do people ever migrate?"
- "What environmental changes cause people to migrate?"

Ask the class to watch and study the flight patterns of birds. (Some species of birds have definite flight patterns which can be identified; for example, flap-flap-flap-glide or flap-glide, flap-glide.)

Have the children finger-sketch in the air the flight patterns they observe.

Suggest to the pupils that a bird-flight pattern has a certain beauty that can be captured by putting it into an art form. Ask them for any ideas they might have as to how to do this. (A well-observed pattern can become the basis of a creative dance such as a step-step-step-slide, or the meter for poetry, or the line for painting or sketching, or the rhythm for music.)

Encourage the children to use the patterns they have chosen in ways that show the beauty, the symmetry, and the gracefulness of the flights of birds.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Magnifying glasses – one per pupil

Movie projector (16mm)

MATERIALS FOR ACTIVITIES

A large sheet of light-colored paper, 24″ x 36″, with a 24″-diameter circle and its center point drawn on the paper

Notebooks and pencils

A small drum and other rhythm instruments

A supply of clay

A variety of art materials (paints, starch, yarn, glue, straws, sticks, pipe cleaners, feathers, wire, and the like)

SELECTED REFERENCES

Books and Articles:

Berrill, Jacquelyn. *Wonders of Animal Migration.* New York: Dodd, Mead & Company, 1964.

Carr, Archie. "How Do Turtles Find the Sea?" *Nature and Science,* VI (January 6, 1969), 12-14.

Kane, Henry B. *Wings, Legs, or Fins.* New York: Alfred A. Knopf, Inc., 1965.

McClung, Robert. *Mammals and How They Live.* New York: Random House, Inc., 1963. (See especially pp. 20-26.)

Morris, Steven W. "Hitch-Hikers of the Sea," *Nature and Science,* IV (March 13, 1967), 11-13.

Ravielli, Anthony. *From Fins to Hands.* New York: Viking Press, Inc., 1968.

Films:

Animals – Ways They Move. Encyclopaedia Britannica Films, Inc., 1956.

Wonder of Grasshoppers. The Moody Institute of Science, 1959.

Lesson Three: Seed Dispersal

This section can be adapted for use with a cluster group simultaneously or with pupils individually. The problems presented here have solutions based on direct observation and provide excellent opportunities for the children to work independently. For the purposes of this lesson, it is recommended that the teacher act as a resource person and offer advice only if it is solicited by the pupil.

The creative writing experiences encouraged in this phase of the unit may have a very direct, personal meaning for some children. What they write, therefore, should be kept confidential if they prefer privacy. These creative activities are planned to give pupils an opportunity to express their own feelings about the world of nature.

Behavioral Objectives

The pupils will learn to identify four categories of seed dispersal. (Knowing, receiving)

The pupils will be able to classify seeds according to the way they disperse. (Comprehension, response)

The pupils will investigate seeds to learn how they disperse. (Analysis, response)

The pupils will be able to relate types of seed dispersal to improved chances of germination. (Application)

The pupils will become acquainted with the method used by Charles Darwin to find out how many seeds are contained in a given amount of soil. (Knowledge)

The pupils will investigate to determine how great a number of seeds is necessary to assure continuation of the species. (Organization, extrapolation)

The pupils will describe the character or quality of nature as it relates to the whimsical, almost haphazard process that results in the continuation of plant life in nature. (Characterization)

Teaching Strategies

The teacher provides an opportunity for the children to note the similarities between things by having the children identify the inherent properties of the seeds.

The teacher will use a game as a problem-solving approach to the stimulation of the skills of search.

The teacher elicits exploratory responses by providing opportunities for the pupils to examine phenomena through experiments.

Under guidance of the teacher, the pupils will study the work of creative people by considering the methods which these persons devised and used.

Suggested Activities

By the time they reach the third grade, many children will have a general understanding of how seeds disperse. In a group discussion the teacher can test to determine whether the pupils are familiar with such categories of dispersal as airborne, clinging, popping or dropping, waterborne, and seeding through animal droppings. If the students are familiar with these categories, the teacher may move on to the seed-box race activity. If categories of dispersal are not clearly understood, the teacher may proceed as follows:

- Enlarged, teacher-made sketches of three or four seeds representing two categories of seed dispersal may be shown on an overhead projector.
- The pupils should experiment with real seeds to determine the type of movement of each seed and to identify the characteristics that permit or enhance this movement.
- The pupils should locate on each projected sketch the sets of seeds that belong in the same categories.

Seed-box Race:

Each pupil should have a shoe box with enough seeds in it to cover the bottom. The seeds should represent several categories of dispersal.

At a signal from the teacher, the children should begin to separate the seeds into piles representing categories of dispersal. The boys and girls should quickly recognize that they need to devise ways to separate the seeds in groups rather than to separate them one by one. (They might draw a strip of cloth through the box to collect the seeds that cling, fan the box to blow out the airborne seeds, and so forth.)

Winning the race – getting all the seeds in the box classified – should not be emphasized, but the methods used to separate the seeds should be discussed.

Further Investigation of Seed Categories:

Clinging seeds should be examined with a magnifying glass or a microscope; the shapes of the hooks and barbs should be compared.

The pupils should make enlarged sketches of the hooks and barbs.

The learners may use the various shapes of these hooks and barbs as individual pieces for a mosaic art project. Each piece of the mosaic should be made in the shape of a hook or barb observed on a seed. The overall design of the mosaic is not to be prescribed.

Airborne seeds should be observed in motion to see whether their motion is consistent or haphazard.

The children should be encouraged to try to find out why some seeds spin or float through the air in a consistent manner. Pupil-created experiments, such as dropping seeds onto a bed of loose sand, will demonstrate how the seeds can penetrate the surface of the soil to improve chances of germination.

Popping or dropping seeds can be observed by hanging ripe but still-closed pinecones or eucalyptus pods in a warm, dry place in the classroom. Light-colored paper should be placed under them. Care must be taken to hang these seed pods in the direction they take when they hang naturally on the trees. In time, the seeds will drop onto the paper.

The concept that humidity is a factor in seed dispersal can be demonstrated by placing an open pinecone and a dandelion with a full head of seeds in a shallow pan with a small amount of water in it, covering the pan with clear plastic, and setting the pan in the sun. The air under the plastic will become more moist. The pupils will observe the pinecone and the dandelion gradually closing. The class should be made aware of the relationship of this phenomenon to the probability of successful germination of the seeds.

The film, *Seed Dispersal,* can then be shown, with the sound turned off.

The teacher should ask the children to recall examples of seed dispersal seen in the film. A list should be made. The children should also identify the categories of dispersal represented.

Next, the teacher can read of an investigation made by Darwin to determine how many seeds were found in a given amount of soil. (See Millicent Selsam's book, *Play with Seeds.*) The pupils should duplicate the experiment.

The film, *Leaf,* can be shown at this point. In this special feature, music is substituted for narration. The music follows the path of an autumn leaf as it soars on the wind in a Yosemite canyon and floats down a stream.

Each learner should write down what he thinks his own feelings might be if he were tossed by the wind and carried gently along by the water, much as a leaf or a seed. The class should be allowed to use either prose or poetry in writing these impressions.

Resource Materials

EQUIPMENT FOR ACTIVITIES

- Magnifying glasses – one per pupil
- Microscopes
- Movie projector (16mm)
- Overhead projector

MATERIALS FOR ACTIVITIES

- Colored construction paper, scissors, paste for mosaics
- A dandelion with a full head of seeds
- Enlarged teacher-made transparencies (for the overhead projector), showing three or four seeds and representing two categories of seed dispersal
- Eucalyptus seed pods
- One inch of sand in a shallow box
- An open pinecone
- Ripe but closed pinecones
- Shoe boxes (or boxes of similar type) – one per pupil
- A variety of seeds, in quantities sufficient to cover the bottoms of all the shoe boxes
- Writing materials

SELECTED REFERENCES

Books:

Hammond, Winifred G. *The Riddle of the Seeds.* New York: Coward-McCann, Inc., 1966.

Jordan, Helene J. *Seeds by Wind and Water.* New York: Thomas Y. Crowell Company, 1962.

Selsam, Millicent E. *Play with Seeds.* New York: William Morrow and Co., 1957. (See especially p. 48.)

Films:

Leaf. Pyramid Film Productions, 1962.

Seed Dispersal (Second edition). Encyclopaedia Britannica Films, Inc., 1957.

Lesson Four:
Temperature – Its Influence on the Environment

To try to assign a particular time allotment to the questioning in this section would be unwise. The pupils might answer the first question so completely that some other questions would be redundant; or there might be a need to spend extra time on particular aspects of the lesson. The teaching-learning situation must be flexible.

This lesson provides excellent opportunities for the children to acquire practice in critical thinking and in the precise communication of their own ideas. As it was pointed out in Chapter 1, the willingness of the teacher to accept unusual ideas while requiring some foundation for them is vital to the classroom climate and is indispensable to pupil motivation.

Behavioral Objectives

The pupils will be able to form hypotheses about the consequences of a loss of heat from the sun to the earth. (Analysis, response)

The pupils will enjoy becoming involved in activities and experiments to support their hypotheses. (Valuation)

The pupils will be able to identify four ways in which life adapts itself to extremes of temperature. (Knowledge)

The pupils will compare the ability of man with that of other animals to adapt to extremes of temperature. (Analysis)

The pupils will show interest in watching for evidences of hibernation taking place in a frog. (Comprehension, response)

Teaching Strategies

The teacher will elicit exploratory responses by proposing questions.

The teacher will encourage the pupils to find answers to their own questions through experimentation.

The teacher can improve the learner's skills in idea generation by motivating him to read and listen discriminately and by providing him with suitable materials for research.

The teacher should arrange activities that will help the children to interact intelligently with their peers. For example, group discussions

of some of the more difficult questions can be held; by taking part in these discussions, the children can develop skills in receiving and responding to the ideas of other persons.

By creating a receptive classroom atmosphere, the teacher can do very much to encourage the development of the pupil's skill in expressing his emotions effectively and constructively. The child feels he is appreciated and respected; therefore, he *wants* to learn and to express himself.

Suggested Questions and Activities

"Could life exist if a barrier were placed around the earth so that no heat could reach the earth from the sun?" The pupils might decide that life would just cease to exist and let it go at that. If such turns out to be the case, they should be reminded that man is an intelligent being and is able to explore the polar regions.

The teacher may then need to ask: "How does man survive in so greatly changed an environment?" In contributing and hearing answers to this question, the children would come to recognize that man is able to explore the polar regions only because he brings with him, from warmer areas, the things that are necessary for survival.

"How would an absence of heat from the sun affect such bodies of water as rivers, lakes and oceans?" The learners may have some questions about ice forming on moving water and on still water, or about ice forming in bodies of salt water or fresh water. This querying can be expanded into an experiment whereby the children freeze tap water and salt water to find out whether there is a difference between their freezing rates. It is important that the pupils set up most of this experiment by themselves, with guidance from the teacher only when needed. They should determine what equipment they require and what procedure they will use, and they should keep records of what happens. After they discover that salt inhibits freezing, they should be encouraged to think of ways in which this information could be used to man's advantage.

"Do you think that the oceans would freeze solid to the ocean floors?"

"If ponds and lakes freeze to the bottom, how do the fish survive?"

"In the polar regions, are the icebergs frozen to the floor of the ocean?"

"Can you think of any benefits that might be derived as a result of a cold earth?" Any of the benefits of refrigeration would be appropriate. Inquiry should be made as to how the products to be refrigerated would be obtained.

"Is the sun the only source of heat for the planet Earth?" If the pupils bring up ways to produce heat for buildings and the like, it would be advantageous for the class to investigate the source of energy for the fuel in question; for example, coal and oil come from plant and animal life, which got its energy from the sun.

"How would the presence of a volcano affect a small area of a cold earth?" Warm air rising from a volcano would create some winds that could be investigated. Warm air rising can be observed in the classroom by using a light bulb to heat the air and suspending tissue paper to make the motion of the air visible.

"Would this result in rain?" The learners should be encouraged to find answers to this and other questions by means of reference materials. It is the teacher's place, at this age level, to make sure that references are found by the children without undue delay and that in each instance the child participates in locating the references.

"Where is the earth hot enough to melt rock?" The existence of heat within the earth, as distinguished from outside heat that comes from the sun, is the concept to be brought out here.

"Two sources of heat for the earth have been identified. How can you tell which source provides the heat necessary to cause seeds to sprout?" A household thermometer can be placed in the ground at various depths to measure temperature differences. The ground should be opened with a trowel and closed quickly so that a temperature change will not be caused by the surface air. The pupils should note that at the surface of the ground the soil temperature is several degrees hotter than it is a few inches below the surface.

"People are part animal. What do people do to make themselves more comfortable when the weather is too cold or too hot?" The responses of the children should be recorded in three appropriate columns without headings. The columns should correspond to certain categories, such as "adapts clothing," "adapts environment" (housing, automobiles, and the like), and "adapts food and beverage." The pupils can then identify the characteristics that are in common with each column and give titles to the columns.

"How do animals solve the problem of adapting to temperature extremes?" The learners should now consider, first through research and then through small-group discussion, the ways in which animals adapt themselves to extremes of temperature. Each group needs a pupil representative who can either write or put on a tape recorder the ideas brought out in the discussion. The learners should be looking for the broad classifications of adaptive abilities of animals, such as hibernation and estivation, rather than examples of individual animal adaptation to temperature extremes.

It would be appropriate at this time to show the films, *The Desert Community* and *Hibernation and Other Forms of Dormancy.* The children should be allowed to add to their lists of broad classifications of adaptive abilities of animals.

"What differences are there between man's adaptive ability and that of other animals?"

The pupils should have the opportunity of watching a frog go into hibernation. The class should be divided into several groups, each containing four or five pupils. Each group should be given a 1-gallon, open-mouth jar with a live frog in it. A mesh covering may be needed to keep the frog in the jar. If the classroom is cool, the frog can be warmed with the heat from a desk lamp. The children will be able to see the frog breathing and will also be able to time its rate of respiration with a stopwatch. They should make a note of any other activity they observe, such as eye movement. The temperature within the jar should be recorded. It would be interesting for each group to plan a way to make its frog go into hibernation. (The jars should be chilled.) Changes in respiration and mobile activity of the frog should also be recorded.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Household thermometers, one per five pupils

Movie projector (16mm)

Stopwatches, one per five pupils

Tape recorders, one per five pupils

MATERIALS FOR ACTIVITIES

Gallon jars (of the type used in school cafeterias) – one per five pupils

Large basins – of a capacity sufficient to hold the glass jars

Live frogs, one per five pupils

A supply of ice for classroom experiments

Transparent containers, all of the same size and shape

SELECTED REFERENCES

Books and Articles:

Fenton, Carroll L., and Mildred A. Fenton. *Our Changing Weather.* Garden City, N.Y.: Doubleday & Company, Inc., 1954.

Kirk, Ruth. "Survival in the Desert," *Nature and Science,* V (October 30, 1967), 4.

Sutton, Ann, and Myron Sutton. *The Life of the Desert.* New York: McGraw-Hill Book Company, 1966.

Webster, David. "Exploring Winter Ice," *Nature and Science,* VI (January 3, 1969), 4.

Wyler, Rose. *The First Book of Weather.* New York: Franklin Watts, Inc., 1956.

Films:

The Desert Community. Encyclopaedia Britannica Films, Inc., 1965.

Hibernation and Other Forms of Dormancy. Encyclopaedia Britannica Films, Inc., 1962.

Lesson Five: Light

Although parts of this section can be done by an individual student, in general it is more suitable for use by a cluster group or by an entire class.

Behavioral Objectives

The pupils will develop hypotheses about the effects of certain variables of light upon the growth of plants. (Application, valuation)

The pupils will carry out experiments to test their hypotheses. (Response, analysis)

The pupils will observe in other organisms certain responses that are due to light sensitivity. (Knowing, receiving)

The pupils will participate in experiences in which their other senses must compensate for the simulated loss of the use of sight. (Analysis, characterization)

Teaching Strategies

The teacher will provide time and materials for the pupils to plan and carry out experiments to test their hypotheses.

The teacher will help the children to improve their skills of search by elaborating upon structures with which they are already familiar.

The teacher will encourage the learners to be on the alert for information that allows one factor to lead to another factor as they listen to readings about phenomena related to light sensitivity not observable in the classroom.

Suggested Activities

Review, through class discussion, previous pupil observations of plants seeking light.

Ask what differences the children think there might be in the growth of a plant if the light on the plant were colored. Discuss ways in which the pupils could find out. (They should consider doing experiments, carrying out research in books and periodicals, asking resource persons, and so on.)

Ask the children whether they believe that the intensity of light might have an effect on seed germination. (Encourage them to give reasons to support their hypotheses.)

Determine whether the pupils can think of other variables of light, such as the amount of light measured by time, or the properties of sunlight compared with those of artificial light.

Allow the learners, individually or in small groups, to choose a variable of light to test by means of an experiment. Each pupil should form a hypothesis about the probable effect his test will have on a plant, write the hypothesis on a piece of paper, and seal the paper in an envelope to be kept in his own desk.

The experiment should then be planned and carried out.

When individuals or members of a group agree that their experiments are completed, they should make written summaries to be shared with the rest of the class.

Each pupil should open his own envelope to see how right or wrong his hypothesis is. (This action is a private one, and the results do not need to be shared with the class unless the child volunteers.) If any experiments have failed completely, the teacher may bring all the pupils together to consider the problems encountered.

Next, provide each child with an earthworm and a magnifying glass. Tell the children to look for eyes. (There are none.)

Have each pupil construct, from a scrap of paper, a small arch that will cast a shadow on one end of his earthworm. Direct him to shine a light on the other end to see if his worm will repeatedly move away from the light. Ask the pupils why earthworms would have any need to be sensitive to light.

Encourage the learners to predict whether snails, ants, sow bugs, ladybugs, and other small creatures would likely be sensitive to light. (They should note that organisms are enabled to adapt themselves to living in certain environments.)

Now, blindfold several pupils. Tell them that they will need to use other senses to substitute for the light that enables them to have sight.

During this experience of temporary "blindness," the children should have no trouble in identifying certain sounds without being able to see what is happening; for example, the scraping of chalk as someone uses it on the chalkboard, or the squeak and the smell of a felt marker as someone writes with it on a chart.

One group of children can devise ways of employing two senses at a time while other groups try to guess, without being able to see. They might try to identify the following: the sound and the feel of moving air as pages of a book are allowed to turn under one's thumb, the sound of pouring a carbonated drink and the feel of its gas bubbles, the impact and the sound of a large book having been dropped on the floor, the taste and the smell of a piece of chocolate candy, and so forth.

Having had several experiences of being able to sense without seeing, the learners will have a better understanding of the adaptive abilities of the bat, as explained in the film, *Blind as a Bat,* which should be shown at this time.

Read to the class the article entitled "How Owls Hunt."

In a lively class discussion, contrast the ways in which bats, owls, and other creatures use hearing to compensate for a lack of light and the inability to see as most animals do.

The very deep parts of the sea are dark. Ask the children whether there is life in such areas and, if so, how it gets along without light. (If there is a general "right now" kind of interest in this subject, the teacher or another pupil can read to the rest of the class. If individual learners are interested, they should be given time to read while their interest is keen.)

Describe a hypothetical situation wherein the members of the class, along with their families, must move to a planet that is totally dark. The people may take anything they need with them when they go, and they will be able to order supplies, at great expense, from the planet Earth. Have the pupils make plans regarding the equipment and supplies to be taken with them. Encourage the class to make one or several dioramas showing life-support systems, recreational facilities, economic provisions and developments, transportation systems, and the like – all of which are intended to make life livable and tolerable on the new planet.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Flashlights – one per three pupils

Magnifying glasses – one per pupil

Movie projector (16mm)

MATERIALS FOR ACTIVITIES

Cloth for blindfolding

Earthworms – one per pupil

Large cardboard cartons for dioramas

Milk cartons of several sizes

Plants – one per pupil (mint, geranium cuttings, and the like)

SELECTED REFERENCES

Books and Articles:

Payne, Roger. "How Owls Hunt," *Nature and Science,* IV (January 30, 1967), 4-7.

Selsam, Millicent, and Betty Morrow. *See Through the Sea.* New York: Harper & Row Pubs., 1955.

Simon, Seymour. *Animals in Field and Laboratory: Science Projects in Animal Behavior.* New York: McGraw-Hill Book Company, 1968. (See especially pp. 7-10.)

Thornton, Nancy M. "Lighting the Way for Plants," *Nature and Science,* VI (December 16, 1968), 6-7.

Films:

Blind as a Bat. The Moody Institute of Science, 1954.

Lesson Six: Food

As in the case of Lesson Five, this section on the eating habits of animals and certain food customs and contributions of man will have appeal for individual pupils. It will be appropriate for use also by a large group or by the class as a whole.

Behavioral Objectives

The pupils will be able to classify animals according to the physical characteristics that determine what they eat. (Comprehension, response)

The pupils will be able to explain the relationship between plant life and the survival of animal life. They will be able to distinguish between herbivorous animals and carnivorous animals. (Synthesis, organization)

The pupils will be able to describe some of the difficulties that would likely be experienced by man or beast in reestablishing a food supply after a natural disaster has occurred. (Analysis, valuation)

Teaching Strategies

The teacher will use the question technique in order to draw close attention to the relationships that exist among availability of food, ability to consume food, and survival.

The teacher will use a film to show in detail how the body parts of various animals are related to their eating habits.

The teacher will use an art project to illustrate the dependency of one life form upon another for survival.

The teacher will use class discussion to stress the concept of man's need for a balance of nature.

Suggested Activities

Ask the learners to name things that birds eat. From this list, make a chart that shows the things eaten in each case, the kind of beak needed for the particular food or foods, and the kind of bird that is being considered. An example of such a chart follows:

Kind of food	*Kind of beak*	*Kind of bird*
Food from water	Broad, flat beak with sieve-like teeth	Duck
Rodents, small animals	Hooked beak for tearing flesh	Hawk, owl
Seeds	Short, stubby beak for seed pecking	Quail
Insects from tree bark	Chisel beak or wood-borer	Woodpecker
Nectar from flowers	Sucking beak	Hummingbird

Show the film, *Animals – Ways They Eat.*

Display some illustrations of prehistoric animals.

Encourage the pupils to give logical reasons, on the basis of information they have gleaned from the film, to support their hypotheses about the eating habits of the illustrated prehistoric animals; that is, carnivorous or herbivorous eating habits.

Ask the children to name some carnivorous animals that are found in North America.

Pose the following questions: "Would these North American animals be able to find food if a drought caused plant life to die?" (Accept a "No" answer if the pupils do not perceive at this time the secondary consequences of such a drought.) "What animals might starve?" "Would carnivorous animals be affected if most of the herbivorous animals did starve?"

Ask also: "In what other ways is plant life used by carnivorous animals?" (Plants can be used for shelter, hiding places, perches, nests, and the like.) "How is the balance of nature (in this case, food supply) restored after a disaster such as disease, flood, or fire?"

Begin another line of questioning: "If you were an aphid, what would you eat?" "If you were an aphid, what might eat you?" "If you were a (whatever ate the aphid), what might eat you?" (Continue in this manner to establish a "food chain.")

Provide each pupil with a long strip of adding machine tape. Let each child make an illustrated food chain by starting at the left of the tape with the name of a small life form and adding to the right of that entry the names of increasingly larger life forms that would consume the one designated at its immediate left.

Ask additional questions, such as those suggested in the paragraphs that follow:

"What does man do to avoid starvation between harvesting times?"

"Before refrigeration and canning were invented, which foods could have been stored for long periods of time?"

"Does man ever have too little food?"

"What does man do when a disaster causes a food shortage?"

"What ways has man found to preserve food so that it might be eaten at a later time?" (Methods include refrigerating, canning, dehydrating, freezing, smoking, pickling, pasteurizing, and vacuum packing.)

Encourage interested learners to try out several methods of preserving foods. They should record the relative difficulty encountered in using these methods, along with their own assessment of the quality of the food after it has been preserved for a stipulated length of time.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Movie projector (16mm)

MATERIALS FOR ACTIVITIES

Adding machine tape

SELECTED REFERENCES

Books:

Burt, Olive W. *The First Book of Salt.* New York: Franklin Watts, Inc., 1965.

Joy, Charles R. *Race Between Food and People.* New York: Coward-McCann, Inc., 1961.

Orr, John B. *The Wonderful World of Food.* Garden City, N. Y.: Doubleday & Company, Inc. (Garden City Books), 1958.

Films:

Animals – Ways They Eat. Encyclopaedia Britannica Films, Inc.

Lesson Seven: Water

Like the two preceding lessons, this section on the important relationships between water and life is suitable for individual use. It is also suitable for use by small groups, by a large cluster group, or by an entire class.

Behavioral objectives

The pupils will enjoy making a blueprint to record the root system of a plant. (Knowledge, response)

The pupils will compare root systems of fresh plants with those of dry plants. (Analysis, response)

The pupils will frame precise questions to gain understanding of an observed phenomenon. (Synthesis, organization)

The pupils will express appreciation for the aesthetic qualities of water through art, music, or creative writing. (Valuation)

Teaching Strategies

The teacher will encourage the pupils to improve their skills of observation through recording the characteristics of a fresh plant and contrasting the characteristics with those of the same plant after it has dried.

The teacher will present an unusual phenomenon in order to stimulate the children to ask in-depth questions.

The teacher will make experiments available for young learners to use as models for experiments of their own.

The teacher will use a film to motivate the pupils to express their feelings through the arts.

Suggested Activities

Each member of the group or class should carefully soak the soil off the roots of a freshly dug dandelion or some other small plant.

Each participant should record the configuration of the plant by making a blueprint. (Instructions to the pupil: On an unexposed sheet of blueprint paper, hold the plant in place with a piece of glass. Place the assembled paper, plant, and glass in bright sunlight until the desired color contrast is obtained. Set the blueprint by placing it in a solution of 1 ounce of hydrogen peroxide to 1 gallon of water.)

The children should allow their plants to dry out overnight.

Next, the pupils should list observable changes in their plants due to lack of water. The changes noted should be shared by all the pupils.

Some of the children may want to attempt to restore the plant to its earlier condition.

Cuttings of easy-to-root plants, such as geranium, mint, or pussy willow, should be started.

The learners should speculate about how growth may come from the stems even though the original roots cannot be restored.

Show the class a white carnation (a cut flower). Place it in a glass containing water that has been treated with food coloring. Set the glass in a warm, bright part of the classroom for a few hours. Make no explanations. The pupils will observe a change in the color of the carnation.

Allow the children to speculate about what has happened and to form their hypotheses into questions that can be answered by a "Yes" or a "No" from the teacher.

Encourage the pupils to participate in the activities described in the paragraphs that follow:

The class should read about the movement of water in plant stems and roots (Selsam, *Play with Plants*). Some of the experiments featured in Selsam's book should be tried.

Pupils showing exceptional interest may be attracted to a project designed to measure the pressure that forces liquid upward in plants (Klein and Klein, "The Sap Is Rising").

Freshly picked, individual leaves of various kinds should be tested for rates of transpiration by putting them in sealed plastic bags and placing the bags in warm sunlight.

The children should observe the leaves and classify them under certain categories, such as "needlelike," "waxy," and "broad."

The pupils should make generalizations about the relationship between physical characteristics of leaves and their rate of transpiration.

The learners should try to create experiments that will enable them to see how roots reach for water.

The teacher should read from the special-topic issue of *Nature and Science* entitled "Life in the Deserts."

The members of the class should plan a number of ways they might use to survive in a desert.

The pupils should dig a cone-shaped hole in an area where the sun will shine on the soil. A sheet of plastic should be placed over the hole in such a way that there are no openings. Moisture will begin to collect on the underside of the plastic. The class should discuss how and why this is happening, and a method should be chosen to collect the moisture so that it can be used. (If the plastic is allowed to sag slightly, droplets of water will gather at the low point and drop off.)

Conduct a class discussion about the fact that many people living in communities have expended tremendous effort to provide water for themselves.

Show the film, *Rainshower.* In this unique film, interpretive music and natural sounds take the place of narration.

Ask the children to express creatively their thoughts and feelings about the aesthetic qualities of water. The teacher might refer to these qualities as "the nice things we find" about water or "the things we enjoy" about water. The child should be allowed freedom of choice in the manner of expressing himself. He may use prose or poetry, painting or sketching, music, drama, or whatever, as long as he feels that he is communicating his ideas. Some of the pupils may want to share their work with the class. Those who would rather not share it should not be forced to do so. It is important, moreover, that everyone in the class understand clearly that no grades will be given.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Movie projector (16mm)

MATERIALS FOR ACTIVITIES

Blueprint paper
Food coloring
Hydrogen peroxide
Plastic sandwich bags
A plastic sheet, 4′ x 4′ or larger
A white carnation (cut flower)

SELECTED REFERENCES

Books and Articles:

Klein, Richard M., and Deana T. Klein. "How Roots Reach for Water," *Nature and Science,* V (January 8, 1968), 14-15.

Klein, Richard M., and Deana T. Klein. "The Sap Is Rising," *Nature and Science,* V (March 4, 1968), 2-3.

"Life in the Deserts" (special-topic issue), *Nature and Science,* V (October 30, 1967).

Selsam, Millicent E. *Play with Plants.* New York: William Morrow and Co., 1949. (See especially pp. 46-52.)

Films:

Rainshower. Produced by Dimension Films, 1965; distributed by Churchill Films.

Lesson Eight: Erosion

The relationships between erosion and the balance of nature are of great importance to a study of ecology. Since young children are naturally curious about the visible world around them, the many causes of erosion – wind, rain, fires, storms, water flow, land shifts, and the like, as well as the use and abuse of nature by man and the need for man's control – will likely hold much attraction for the pupils as they learn the concepts of this lesson and apply some of these concepts in experiments and projects.

Although most of the material presented here is appropriate for use by individuals and by small groups, the class as a whole can become involved in the suggested learning experiences and can benefit greatly in so doing.

Behavioral Objectives

The pupils will carry out experiments to determine the conditions controlling the amount and kinds of erosion that take place. (Analysis, response)

The pupils will discuss the effects of erosion in relation to a balanced ecology. (Synthesis, response)

The pupils will express feelings of social responsibility with respect to erosion caused by man. (Synthesis, characterization)

Teaching Strategies

The teacher will provide opportunities for the children to observe erosion taking place on a small scale by means of classroom experiments.

The teacher will make use of a film to illustrate erosion on a large scale.

The teacher will utilize group discussion to draw attention to the interrelationships between man and erosion.

Suggested Questions and Activities

Paint several large pieces of cardboard with calcimine solution and let the pieces dry.

Ask the pupils how they themselves might be able to cause the paint to erode. Allow them to work in small groups for the purpose of trying to erode the calcimine.

As methods to erode the paint are devised, they should be recorded by the pupils on the chalkboard.

In a class discussion, have the learners identify examples of erosion in nature that parallel the eroding processes used on the calcimine. For example, the children may have used some kind of abrasion that would have its parallel in nature with wind and water abrasion or with abrasion caused by people and animals on heavily traveled paths.

Make two garden-type nursery flats watertight by lining them with plastic. Fill one flat with rich loam and another with sandy soil. Scatter mustard seed rather thickly on each flat.

When the seeds have sprouted, cover one-half of each flat with plastic to protect it. With the flats slightly tipped, wind and rain can be simulated to demonstrate the differences in erosion on different kinds of soil.

Next, pull out a 1-inch-wide strip of mustard sprouts from side to side of one of the boxes. Place the box with the cleared strip in a horizontal position and repeat the rain simulation procedure. The pupils will be able to see erosion in the cleared strip. Then tip the box with the strip to an uphill position and water both boxes again. These actions will speed up the erosion considerably in the box with the cleared space.

Ask the children why the two flats were not affected by the wind and the water in the same way.

Give each pupil a teaspoonful of soil from both flats. A sharpened pencil can be used for a tool with which to separate the soil into small piles consisting of pieces of plant matter, sand, and the like.

Comparisons should then be made of the composition of the two kinds of soils; and conclusions should be drawn about the relationship between the composition of the soil and the rate of erosion.

Children who show particular interest in soil composition should be encouraged to compare more kinds of soil and also to "build" some soil. They can then test several kinds of soil for characteristics of water retention or compaction and explain their findings to the rest of the class.

Show the film, *Erosion – Leveling the Land,* to illustrate erosion and deposition of soil on a large scale.

Ask the following pertinent questions and call for discussion:

"Does erosion change the life of man?" The class should consider mud slides, earth slippage, sandstorms, silt in water, removal and relocation of topsoil, shifting beaches, and silt-filled harbors and marinas.

"Is all erosion caused by man?" The pupils should consider changes brought about during the Ice Age, fire caused by lightning, runoff after rain, earth movement along fault lines causing rechanneling and other changes in streams and rivers, alterations wrought by the wind, effects of exfoliation, slides caused by animal tunnels, and meadows created by beaver dams.

"Are the results of erosion always harmful?" The children should consider Yosemite Valley, San Francisco Bay, mountain passes, and the use of rivers for transportation.

"Can man do anything about erosion?" The learners should consider contour farming; the provision of plant covering for bare ground; the reseeding of burned areas; the construction of mud control dams, drainage channels, and breakwaters; and other methods of prevention and control.

"Should man try to control all or nearly all erosion?" It is not necessary to elicit general agreement here. The prime concern of the teacher at this time is for each pupil to form an opinion and to have some reasons to support it. Opportunity should be provided for the children to reevaluate their thinking, and the question should be left open-ended.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Movie projector (16mm)

MATERIALS FOR ACTIVITIES

Calcimine paint
Cardboard – a supply of assorted large pieces
Garden-type nursery flats (two)
Mustard seeds
Flastic sheets – four pieces, each 3′ x 3′
Sprinkler bottles or cans

SELECTED REFERENCES

Books and Other Publications:

Bauer, Helen. *Water: Riches or Ruin.* Garden City, N.Y.: Doubleday & Company, Inc., 1959.

Bendick, Jeanne. *The Wind.* Chicago: Rand McNally & Co., 1964. (See especially pp. 62-63.)

Colby, Carroll B. *Soil Savers.* New York: Coward-McCann, Inc., 1957.

Foster, Albert B., and Adrian C. Fox. *Teaching Soil and Water Conservation: Classroom and Field Guide* (Revised edition). Program Aid Series, PA-341. Prepared under the direction of the Soil Conservation Service. Washington, D.C.: U. S. Department of Agriculture, 1964.

Gaskell, Thomas F. *World Beneath the Oceans.* American Museum of Natural History. Garden City, N.Y.: Doubleday & Company, Inc., 1964. (See especially pp. 78-81.)

Vessel, Matthew F., and Herbert H. Wong. *Seashore Life of Our Pacific Coast.* Palo Alto, Calif.: Fearon Publishers, Inc., 1956. (See especially pp. 3-6.)

Films:

Erosion – Leveling the Land. Encyclopaedia Britannica Films, Inc., 1965.

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